

[0028] The construction of the organic EL device used in the present invention will be set forth hereinafter. The structure of the organic EL device used in the present invention will be described at first. The construction of the organic EL device used in the present invention is not particularly limited and may take an arbitrary construction. Examples of the construction include constructions such as anode / light emitting layer / cathode, anode / hole injecting layer / light emitting layer / cathode, anode / light emitting layer / electron injecting layer / cathode and anode / hole injecting layer / light emitting layer / electron injecting layer / cathode. For example, each of these layers may comprise a laminate of a plurality of layers or mixed layers comprising a plurality of materials. Each of these organic layers can be formed in accordance with the resistance heating process as proposed in the Japanese Patent Application No. H05-028659 by heating and evaporating an organic material in a boat or a filament and depositing the evaporated organic materials on an electrode at another side to form a layer of an organic material. The thicknesses of each layers are not particularly limited. Thicknesses of the layers except cathode and anode are usually 5 nm to 5 μ m. The materials are not particularly limited so long as the materials are those used usually for organic EL devices. A structure of an organic EL device comprising anode / hole injecting and transporting layer / light emitting layer / electron injecting and transporting layer / cathode will be described in the following.

[0029] (1) Substrate

It is preferable that the structure used in the present invention is formed on a substrate. It is preferable that the substrate used in the present invention is transparent. Examples of the substrate include glass, transparent plastics and quartz.

[0030] (2) Electrodes

The electrodes used in the present invention comprises a pair of electrodes (cathode and anode) opposite each other at least one of which is transparent or translucent for the purpose of securing transparency.

(2) - 1 Anode

As the cathode used in the present invention, an electrode using a metal, an alloy, an electrically conductive compound or a mixture of these materials which has a large work function (4 eV or larger) as the electrode material can be used preferably. Examples of the electrode materials include transparent or translucent materials having dielectric property such as a metal like Au, CuI, ITO, SnO₂ and ZnO. The anode can be prepared by forming a thin film in accordance with processes of evaporating or sputtering these electrode materials. In order to take out a light emission from the electrode, it is preferable that the transmittance is larger than 10% and sheet resistance as an electrode is several hundreds Ω/\square or lower and the thickness of the film is usually 10 nm to 1 μm , and preferably in a range of 50 to 200 nm. Furthermore, although the thickness should be determined depending on the material, the thickness can usually be from 10 nm to 1 μm , preferably from 10 to 200 nm.

[0031] (2) - 2 Cathode

Whereas, as the cathode, an electrode using a metal, an alloy, an electrically conductive compound or a mixture of these materials which has a small work function (4 eV or less) as the electrode material can be used.

Examples of these electrode materials include sodium, a sodium-potassium alloy, magnesium, lithium, a mixture of magnesium/copper, Al/(Al₂O₃), indium and rare earth metals. The cathode can be prepared by forming a thin film in accordance with processes of

evaporating or sputtering these electrode materials. It is preferable that the sheet resistance as an electrode is several hundreds Ω/\square or lower and the thickness of the film is usually 10 nm to 1 μm , and preferably in a range of 50 to 200 nm. Furthermore, it is preferable that one of said anode or cathode is transparent or translucent in order to improve the efficiency of obtaining the light emission, thereby the transmittance of the light emission by the electrode itself is enhanced.

[0056] And, electrically insulating high polymers can be used suitably as the other material of the protective layer. As the electrically insulating high polymers, high polymers which can form films by physical vapor deposition process (sometimes referred to as PVD process hereinunder), high polymers which can form films by chemical vapor deposition process (sometimes referred to as CVD process hereinunder), or high polymers which are soluble in fluorine-based solvents such as perfluoroalcohols, perfluoroethers or perfluoroamines. It is particularly preferable that the high polymers have a small humidity transmittance. Examples of each of the electrically insulating high polymers include following compounds.

[0057] (1) Electrically insulating high polymers capable of forming films by PVD process

Polyethylene, polypropylene, polystyrene, poly(methyl methacrylate), polyimide (a polymer obtained by depositing and polymerizing 2 kinds of monomers on a substrate, cf.: Technical Journal, 1988, 30, 22), polyurea (a polymer obtained by depositing and polymerizing 2 kinds of monomers on a substrate, cf.: Technical Journal, 1988, 30, 22), fluorine-based high polymer disclosed in JP S63-18964, fluorine-based high polymer disclosed in JP S63-22206, fluorine-based high polymer disclosed in JP S63-238115,

polytetrafluoroethylene, polychlorotrifluoroethylene, polydichlorodifluoroethylene, copolymers of chlorotrifluoroethylene and dichlorodifluoroethylene, fluorine containing copolymers having an alicyclic structure (cf.: JP H03-129852), etc.

[0058] (2) Electrically insulating high polymers capable of forming films by CVD process [Plasma Polymerization Process (Plasma CVD)]

Polyethylene, polytetrafluoroethylene, polyvinyltrimethylsilane, polymethyltrimethoxysilane, polysiloxane, etc.

[0059] (3) Electrically insulating high polymers soluble in fluorine-based solvents such as perfluoroalcohols, perfluoroethers, perfluoroamines, etc.

Fluorine-based high polymer disclosed in JP S63-18964, fluorine-based high polymer disclosed in JP S63-22206, fluorine-based high polymer disclosed in JP S63-238115, polychlorotrifluoroethylene, polydichlorodifluoroethylene, copolymers of chlorotrifluoroethylene and dichlorodifluoroethylene, fluorine containing copolymers having an alicyclic structure (cf.: JP H03-129852), etc.

[0060] The protecting layer can be formed in accordance with PVD process (for high polymers set forth in (1) above), CVD process (for high polymers set forth in (2) above), or cast-coating or spin-coating process (for high polymers set forth in (3) above), respectively, corresponding to the high polymers used. The thickness of the protective layer may be determined depending on the material and the process for forming the layer and is preferably 10 nm to 100 μm . When the protective layer is formed on the side of light emitting surface, the material and the process for forming the protective layer is selected so that a protective layer which is excellent in transparency to the EL light from the organic EL device can be obtained. The examples of processes for forming the protective layers in accordance with the respective

processes are shown below.

• PVD process

Same processes as those set forth with respect to the inorganic electrically insulating high polymers can be used. The conditions of forming films depend on the material and the process applied. For example, when vacuum evaporation process (the resistance heating process, electron-beam heating process, high frequency induction heating process) is applied, the degree of vacuum before evaporation is about 1×10^{-2} Pa or less, preferably 6×10^{-3} Pa or less, the heating temperature of evaporation source is about 700°C or less and preferably 600°C or less, the temperature of the substrate is about 200°C or less and preferably 100°C or less. It is preferable that the film is formed at the rate of evaporation of 50 nm/s or less and preferably at 3 nm/s or less.

[0061] • CVD process

Plasma polymerization is preferable in which monomers such as ethylene or propylene is polymerized with plasma. Thermal decomposition CVD which is generally used is not appropriate because of the high temperature of the substrate is inevitable in the process.